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PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	MANFRED SCHMID ET AL	
Serial No.:	[NEW]	Group Art Unit: (not yet assigned)
Filed:	JULY 31, 2003	Examiner: (not yet assigned)
Title:	DEPLOYABLE ANTENNA REFLECTOR	

CLAIM OF PRIORITY UNDER 35 USC § 119

Mail Stop PATENT APPLICATION
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

The benefit of the filing date of prior foreign application No. 02017163.3, filed in the European Patent Office on July 31, 2002, is hereby requested and the right of priority under 35 USC § 119 is hereby claimed.

In support of this claim, filed herewith is a certified copy of the original foreign application.

Respectfully submitted,

July 31, 2003

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Bescheinigung Certificate Attestation

Die angehefteten Unterlagen stimmen mit der ursprünglich eingereichten Fassung der auf dem nächsten Blatt bezeichneten europäischen Patentanmeldung überein.

The attached documents are exact copies of the European patent application described on the following page, as originally filed.

Les documents fixés à cette attestation sont conformes à la version initialement déposée de la demande de brevet européen spécifiée à la page suivante.

Patentanmeldung Nr. Patent application No. Demande de brevet n°

02017163.3

Der Präsident des Europäischen Patentamts;
Im Auftrag

For the President of the European Patent Office

Le Président de l'Office européen des brevets
p.o.

R C van Dijk

Anmeldung Nr:
Application no.: 02017163.3
Demande no:

Anmeldetag:
Date of filing: 31.07.02
Date de dépôt:

Anmelder/Applicant(s)/Demandeur(s):

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81663 München
ALLEMAGNE

Bezeichnung der Erfindung/Title of the invention/Titre de l'invention:
(Falls die Bezeichnung der Erfindung nicht angegeben ist, siehe Beschreibung.
If no title is shown please refer to the description.
Si aucun titre n'est indiqué se referer à la description.)

Deployable antenna reflector

In Anspruch genommene Priorität(en) / Priority(ies) claimed /Priorité(s) revendiquée(s)
Staat/Tag/Aktenzeichen/State/Date/File no./Pays/Date/Numéro de dépôt:

Internationale Patentklassifikation/International Patent Classification/
Classification internationale des brevets:

B64G/

Am Anmeldetag benannte Vertragstaaten/Contracting states designated at date of filing/Etats contractants désignées lors du dépôt:

AT BE BG CH CY CZ DE DK EE ES FI FR GB GR IE IT LI LU MC NL PT SE SK TR

Thus, a geometric minimisation of the envelope of the stowed reflector is achieved not only by optimisation of the panel deployment kinematics but also by deflection of the panels in the stowed configuration.

The diameter of the reflector in the deployed configuration is preferably in the range between 3 or 6 m. The preferred frequency band is X- Band or higher.

An embodiment of the invention will now be described by way of example only with reference to the accompanying drawings of which

FIG. 1 shows a 3-D view of the reflector in the stowed configuration;
FIG. 2 shows a 3-D side view of the reflector partially deployed;
FIG. 3 shows a 3-D view of the reflector fully deployed;
FIG. 4 shows a 3-D top view of the reflector fully deployed;
FIG. 5 shows a 3-D view of a deployment damping device of the reflector (on one panel only);
FIG. 6: shows a 3-D view of a launch lock device of the reflector;
FIG. 7: shows a 3-D view of a detail of the launch lock device (compression rope and unloaded release damping rope);
FIG. 8 shows a 3-D view of a panel hinge and the panel deployment drive (spring);
FIG. 9 shows a top view of the reflector with the sheet-like panels being omitted for reasons of clarity.

FIG. 1 illustrates the reflector according to the invention in its stowed configuration, i.e. during launch. The individual sheet-like panels P made of CFRP are hingedly connected to a central supporting ring R which provides the structural interface to the satellite and to the tripod/ feed TP assembly of the reflector as well. In addition, the central dish CD (FIG. 4) of the reflector which is also designed as a thin-walled CFRP membrane element is fixedly connected to the central supporting ring R. Preferably, each thin sheet-like panel P is supported by a hollow CFRP rib RB which connects a panel P to the central dish DC via mechanical bushings. As can be supposed from

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D ployable Antenna Reflector

The invention relates to a deployable antenna reflector.

Future communication satellites require medium size lightweight deployable antenna reflectors which can be stowed during launch on a satellite in a minimised available envelope and are deployed during mission.

It is the object of the invention to provide a deployable antenna reflector having a minimum envelope in its stowed configuration.

This goal is achieved by the deployable antenna reflector according to claim 1. Preferred embodiments of the invention are the subject of additional claims.

The reflector according to the invention is a so called thin sheet reflector comprising sheet-like deployable panels preferably made of CFRP (Carbon Fiber Reinforced Plastic) arranged around a fixed central reflector dish. The rotation axes of the deployable panels are tilted with respect to the center point of the central dish in order to optimise the storage envelope. The panel movement is not directed radially with respect to the center point of the reflector dish but shows a certain deviation.

The reflector according to the invention allows to deflect the deployable panels during storage on their upper edges and to achieve the nominal well defined parabolic reflector contour after deployment by relaxing the panel deflection.

FIG. 1 the upper inner edges of the thin sheet-like panels P are bent in the stowed configuration. Upon deployment relaxation of the panels P takes place (FIGS. 2 to 4).

FIG. 4 shows the reflector in its fully deployed configuration. The central dish and the deployed sheet-like panels arranged around the central dish together form the overall reflector surface.

It is an essential feature of the invention that the deployment axis of each sheet-like panel P is tilted with respect to the centre of the reflector in order to optimise geometrically for minimum stowed envelope. In other words, the longitudinal axis (anlongside the ribs RB) of each individual sheet-like panel P is not oriented radially with respect to the center point of the central dish CD but in an inclined orientation in order to achieve geometric minimalisation during storage. As can be best seen in FIG. 4 the longitudinal axis of each panel is tangent to a circle having the center point of the central dish CD as its center.

The aspect of tilted rotational axis´ with respect of the center point of the central dish is further explained by means of Fig. 9. It depicts an reflector according to the invention (top-view, the sheet–like panels have been omitted for the sake of clarity). The hinges H of the sheet-like panels P are arranged on a circle around the center point M of the central dish CD. The rotational axis RA of each hinge H is oriented in such a way that it does not form a tangent to said circle.

Preferably, the individual panels are not coupled after deployment in order to achieve a final parabolic contour which is not sensitive to any cross coupling effects between the panels. Each individual panel provides a well-defined parabolic contour and the upper rim of each panel can be fine-tuned in height completely independently from the other panels.

On top (as seen in the stowed configuration) of each panel P and preferably supported by a rib RB a metal launch lock bracket LLB is mounted in order to form a closed form-locking structural ring in the stowed configuration (FIG. 6). This structural ring is loaded by a circumferential rope CRO (FIG. 7) allowing to compress the ring

segments formed by the brackets LLB with respect to each other during launch in order to form a stiff structural ring transferring moments and lateral forces as well. All launch loads are guided through the panel ribs RB down to the structural interface on the central supporting ring R.

To release the reflector the compression rope CRO is cut (FIG.7) and the deployment is initiated by means of torque springs TSP present at each hinge H of a sheet-like panel P and acting on the rotation axis thereof (FIG.8). Turning now to FIG. 5, during deployment the motion is damped by means of a damping device DD which is preferably mounted on top of a panel P. The damping device DD shown in FIG. 5 is fit into one launch lock bracket LLB´ the shape of which has been adapted accordingly. A thin rope DR (FIGS. 5,7) guided along all launch lock brackets LLB is pulled off a small cable drum CDR attached to the damping device DD so that the overall release motion of all panels P is damped simultaneously. The damping device may be a eddy current damping device but any other kind of damping device may be used. Synchronisation of the deploying panels P is achieved inherently by the reflector design concept (FIG. 2). Only in the final deployed end position all panels are located one beside the other (with a certain overlap between neighbouring panels, see FIG. 4) and no longer one behind the other.

After complete deployment about the spring loaded panel rotation axis close to the lower edge of each individual panel, the deployed end position is kept by means of a magnetic end stop element attached to the central supporting ring. This interface mates to the very end of the panel rib which carries an adequate metallic endstop fitting. The torque spring TSP still acting on the deployment RA axis suppresses residual backlash in the deployment hinge H.

The structural ring R is designed as a hollow CFRP ring providing the end stops for the deploying panels (FIG. 3) as well as the bearing of the deployment axis RA of each individual panel P.

Claims

1. Deployable antenna reflector, comprising a central dish (CD) and a plurality of deployable sheet-like panels (P) arranged around the central dish (CD), the reflector further comprising a central supporting body (R), whereon the central dish (CD) is fixedly mounted and whereto the deployable sheet-like panels (P) are hinged, whereas the rotation axes (RA) of the individual deployable sheet-like panels (P) are tilted with respect to the center point (M) of the central dish (CD) and whereas in the stowed configuration of the reflector the deployable sheet-like panels (P) are at least partially deflected in order to minimise the envelope of the reflector and that the panels (P) relax upon deployment.

2. Deployable antenna reflector according to claim 1, whereas each sheet-like panel (P) is supported by a rib (RB) which connects the sheet-like panel (P) to the central supporting body (R) via mechanical bushings.

3. Deployable antenna reflector according to any one of the preceding claims, whereas each sheet-like panel (P) includes a torque spring (TSP) acting on the rotation axis (RA) thereby driving the sheet-like panels (P) from the stowed configuration into the deployed configuration.

4. Deployable antenna reflector according to any one of the preceding claims whereas brackets (LLB) are mounted at the outer end of each sheet-like panel (P) forming a closed formlocking structural ring in the stowed configuration of the reflector.

5. Deployable antenna reflector according to any one of the preceding claims, whereas in the stowed configuration of the reflector the structural ring is loaded by a circumferential rope (CRO) allowing to compress the individual brackets (LLB) with respect to each other.

6. Deployable antenna reflector according to any one of the preceding claims, whereas a damping device (DD) is mounted on one of the sheet-like panels (P) in

order to simultaneously damp the motion of the sheet-like panels (P) during deployment.

7. Deployable antenna reflector according to claim 6, whereas the damping device (DD) cooperates with a cable drum (CDR) on which a damping rope (DR) is wound said damping rope being guided around the formlocking ring in the stowed configuration.

8. Deployable antenna reflector according to any one of the preceding claims whereas the central supporting body (R) is a hollow ring made of CFRP.

9. Deployable antenna reflector according to any one of the preceding claims whereas the deployable sheet-like panels (P) are made of CFRP.

Abstract

The invention relates to a deployable antenna reflector comprising a central dish (CD) and a plurality of deployable sheet-like panels (P) arranged around the central dish (CD). The reflector further comprises a central supporting body (R), whereon the central dish (CD) is fixedly mounted and whereto the deployable sheet-like panels (P) are hinged. The rotation axes (RA) of the individual deployable sheet-like panels (P) are tilted with respect to the center point (M) of the central dish (CD). In the stowed configuration of the reflector the deployable sheet-like panels (P) are at least partially deflected in order to minimise the envelope of the reflector and that the panels (P) relax upon deployment.

(Fig. 1)

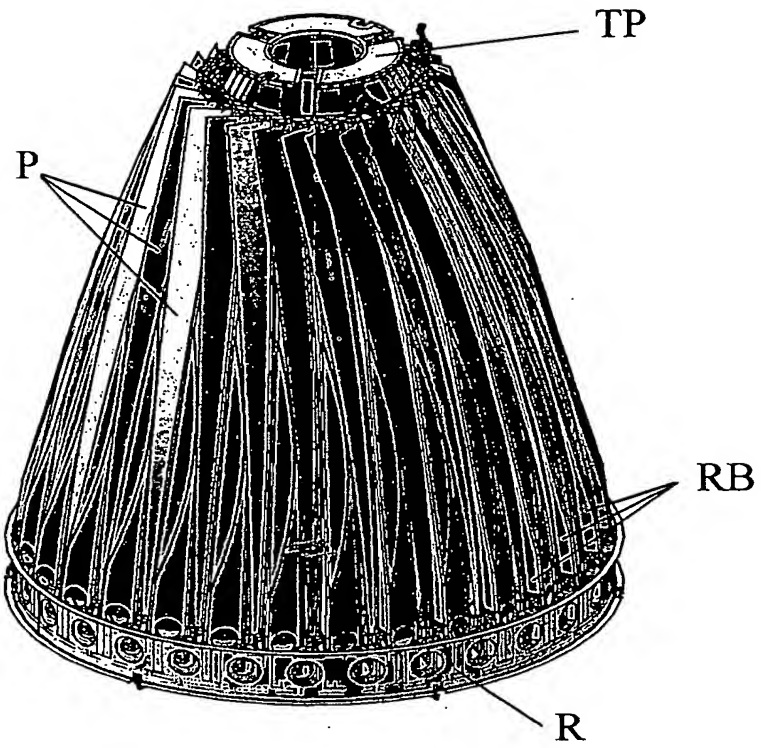

Fig. 1

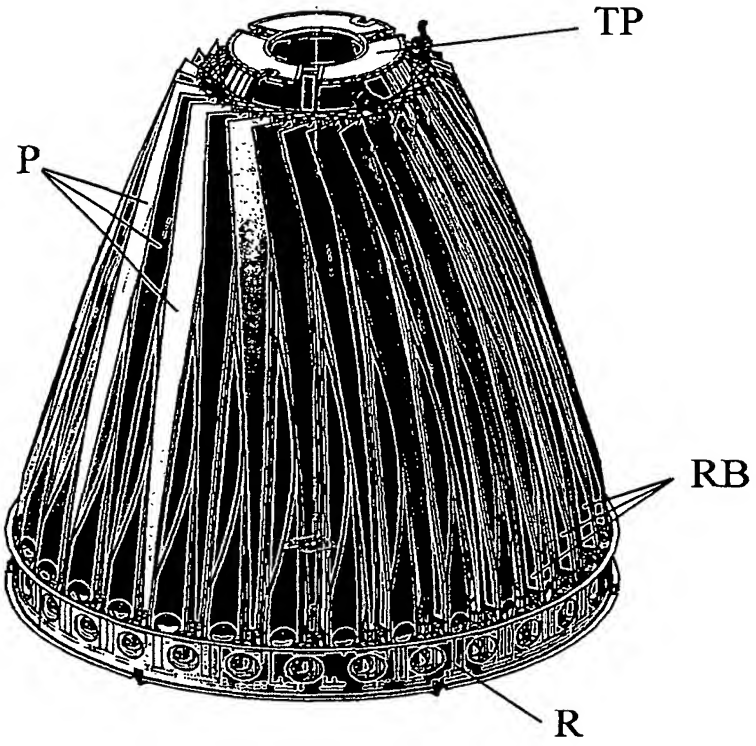

Fig. 1

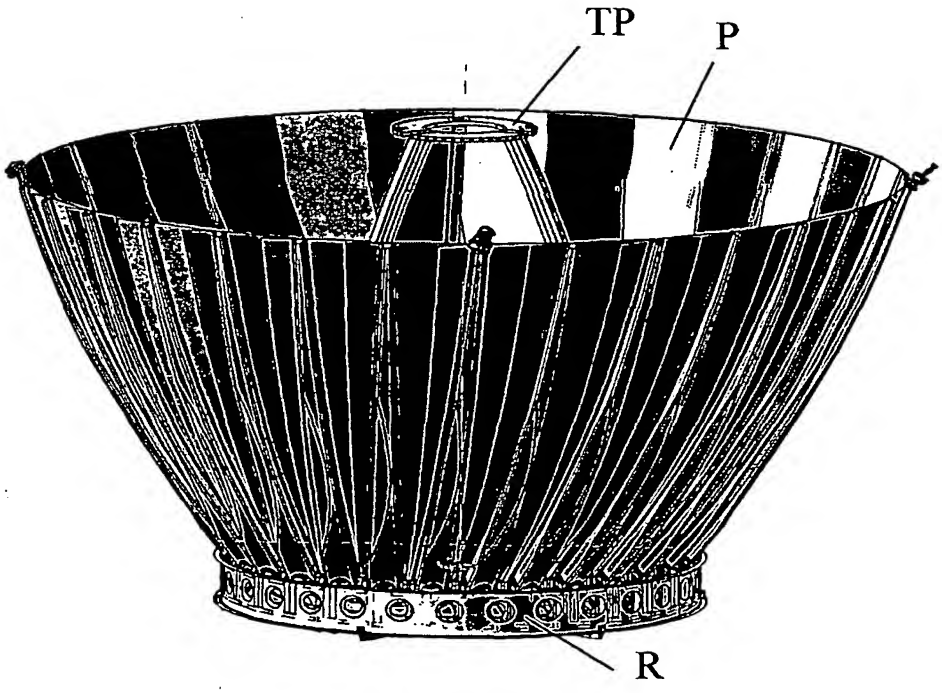

Fig. 2

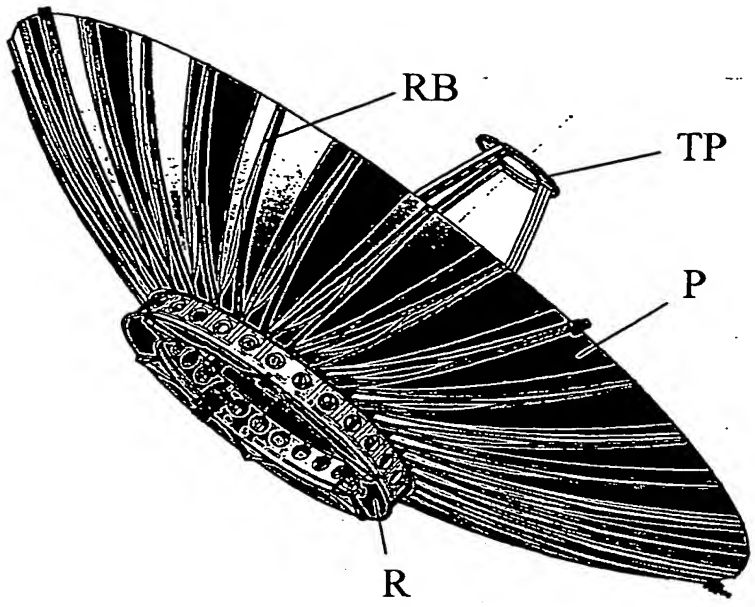

Fig. 3

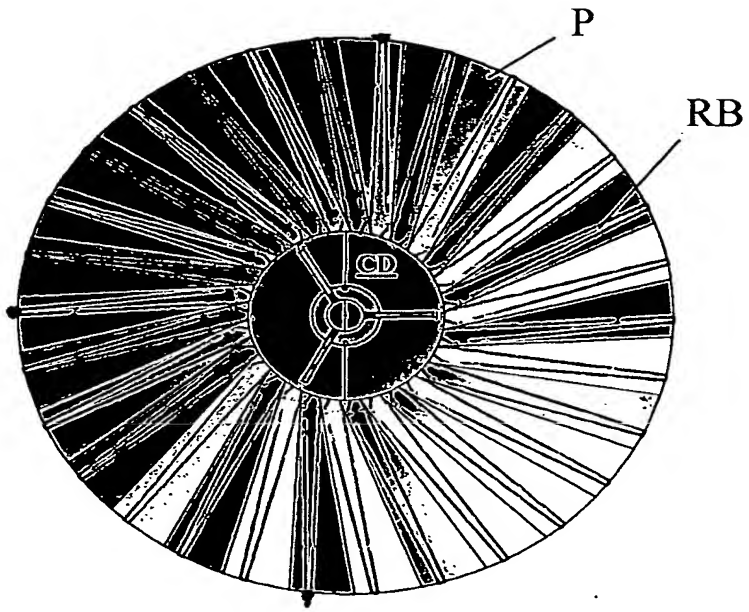

Fig. 4

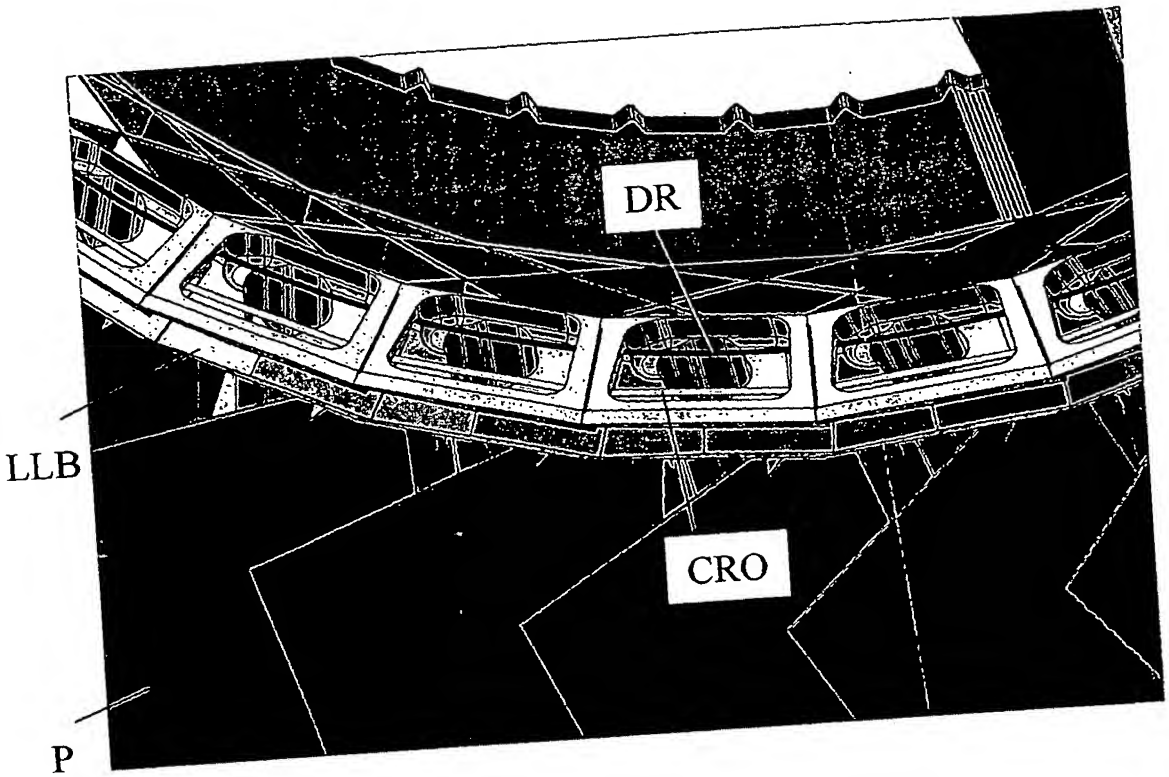

Fig. 7

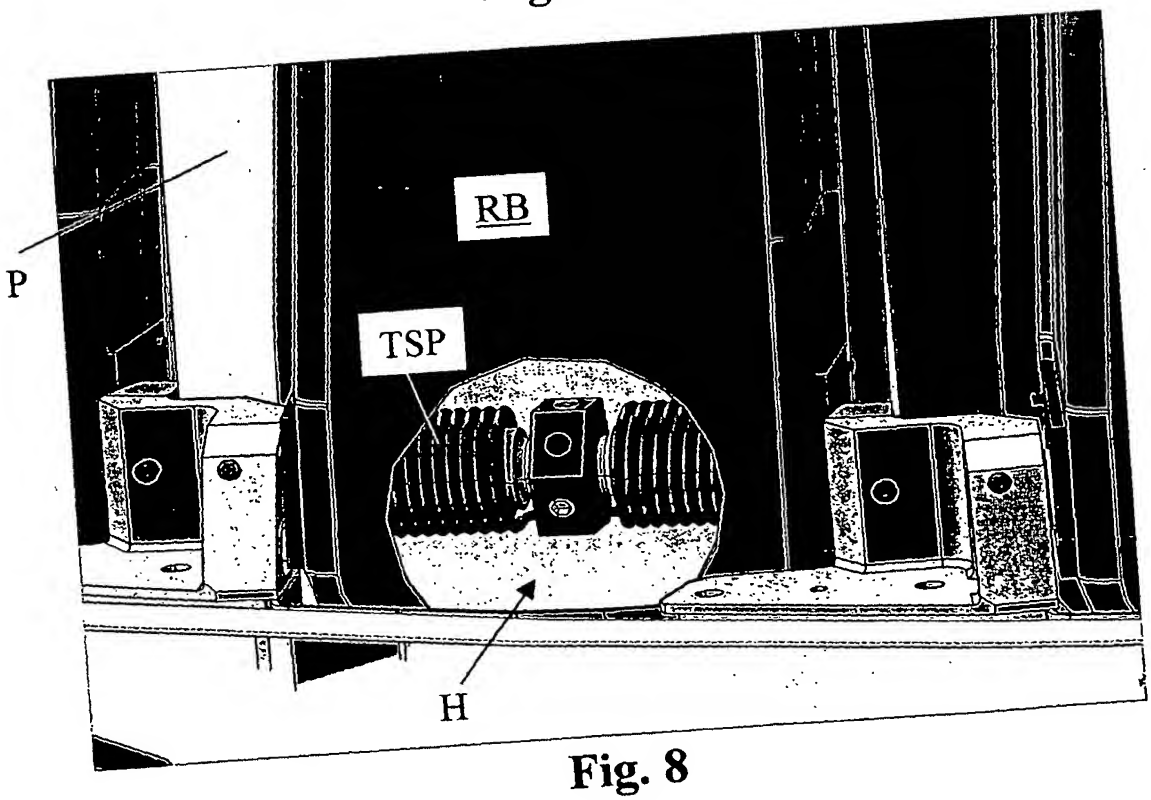

Fig. 8

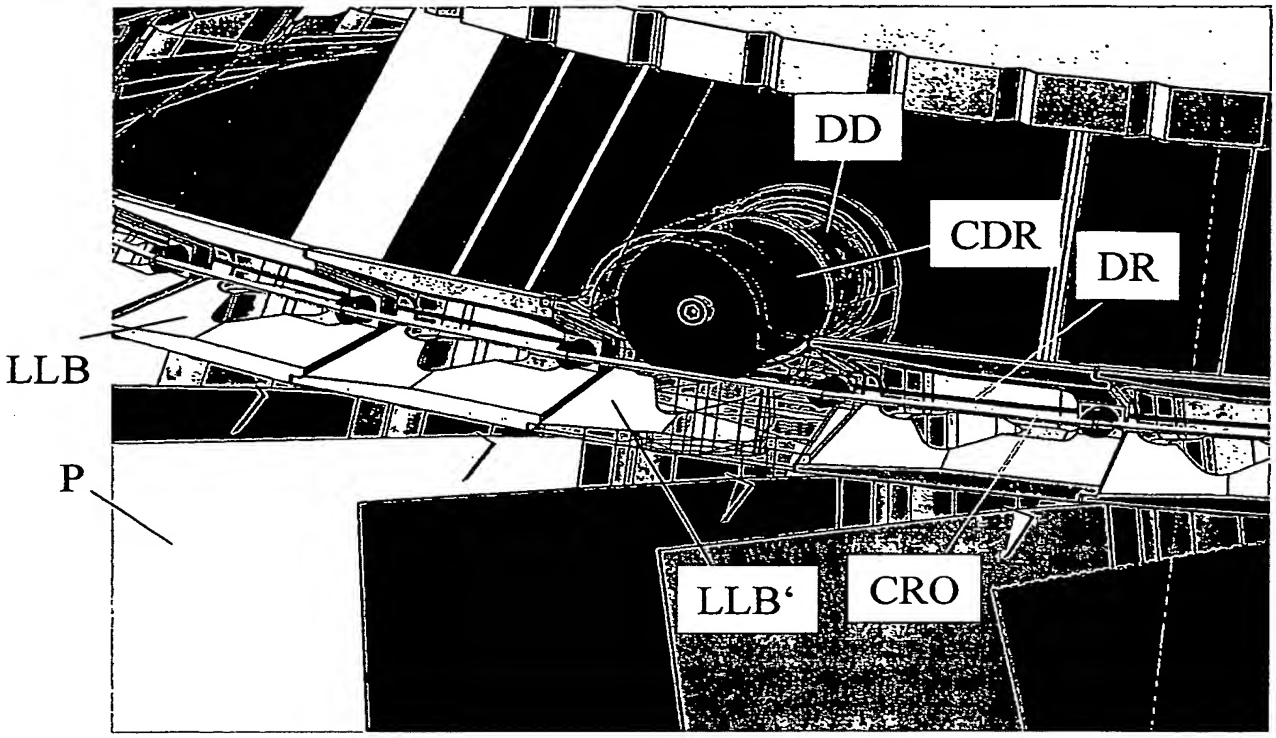

Fig. 5

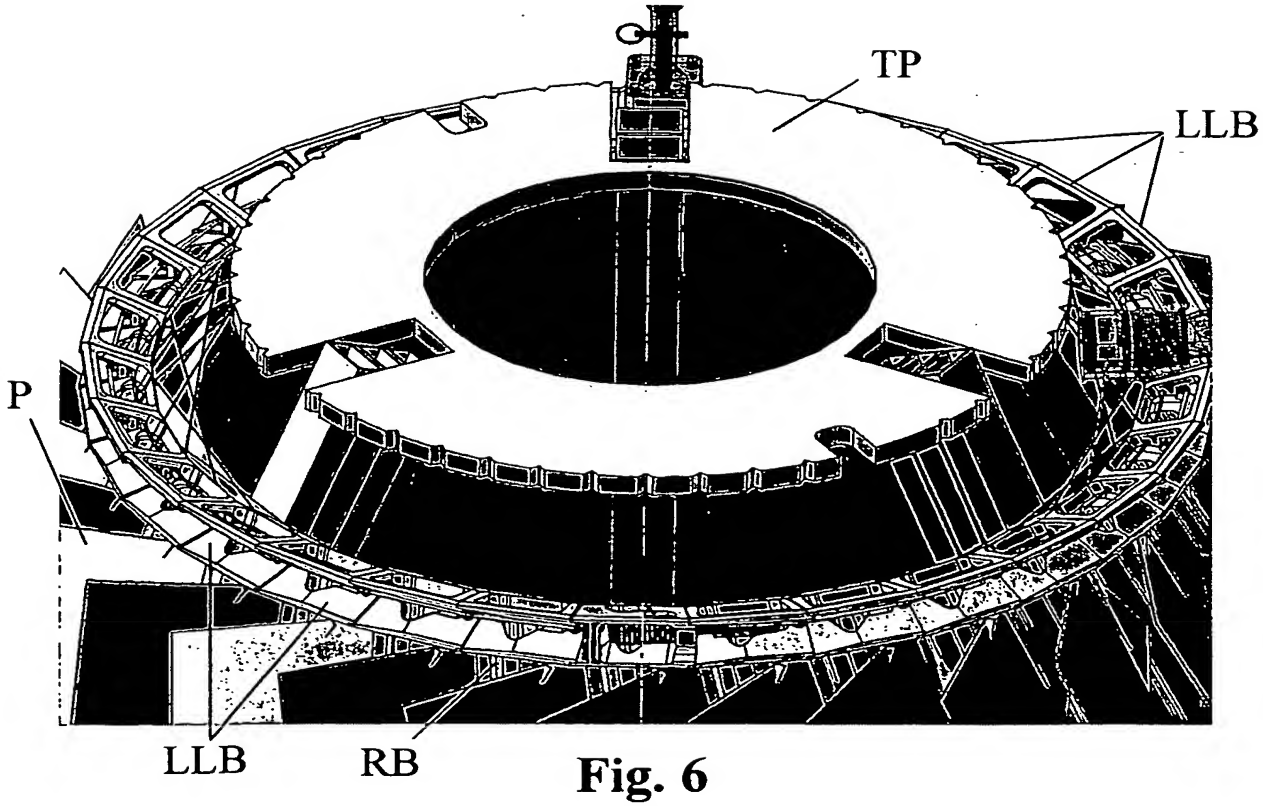

Fig. 6

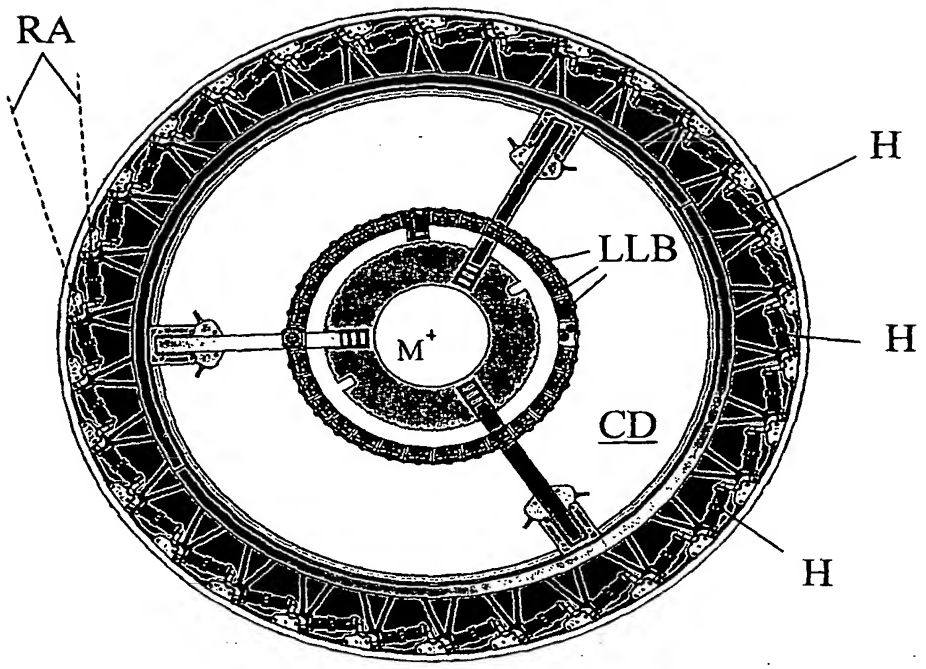

Fig. 9